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Radioactive Isotope Physics Laboratory Chief Scientist Review 2013

Laboratory: Radioactive Isotope Physics Laboratory
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The following report is the consensus view of the panel.

General Comments:

The review panel considered material provided to us prior to the review and during a one-day meeting at the Nishina Center on 21 January 2013. We heard presentations from Director En'yo and Professor Sakurai, and had time to discuss Professor Sakurai's performance and leadership with the scientists working under him in the Radioactive Isotope Physics Laboratory. In the following report we comment about the research objectives of the laboratory, the research results, the management, and the future research plans.

Our overall conclusion is that Professor Sakurai is performing at an exceptional level and that the Radioactive Isotope Physics Laboratory is world-leading in its area of research. The laboratory pursues and enables forefront research into the nature of atomic nuclei and provides an important role in encouraging significant international participation in the Nishina Center Radioactive Ion Beam Factory.

Research Objectives

The primary research areas explored by Dr. Hiroyoshi Sakurai's group are; shell evolution, dynamics of neutron skins and halos, nucleosynthesis primarily related to the r-process, and the EOS of asymmetric nuclear matter. All of these programs are forefront and important subjects in nuclear physics. The combination of the world's highest intensity radioactive nuclear beams and the unique experimental facilities developed at RIKEN (such as DALI2, CAITEN, WAS3Bi, SAMURAI TPC and SHOGUN) and those contributed on a temporary basis from collaborators abroad (such as EURICA, MINOS and MUST2) ensures a world-leading role for Sakurai's laboratory. In addition, the exploration by Professor Sakurai of novel experiments such as the laser spectroscopy in superfluid helium and the search for the footprints of galactic supernovae in Antarctica ice core is a good sign that the Laboratory is continuing to innovate and move into new areas. These activities are a sign of good leadership and are to be encouraged.

Research Results

Under the leadership of Professor Sakurai, the Rare Isotope Laboratory has an impressive record of scientific output with 215 refereed publications and approximately 140 invited talks in the past 7 years. This includes 6 Physical Review Letters in 2012 and an average of 5-6 letters/year over the most recent few years. These results are a reflection of the tremendous research potential offered by the RIBF facility, but are also a reflection of Professor Sakurai's pursuit of the most high-impact science offered by this facility. The results are also a consequence of equipment innovations make within the laboratory as noted above.

In the area of gamma-ray spectroscopy, the center has a number of high-impact results. These include discovery of unusual deviations in the normal correlation between excitation energy and transition strength in heavy carbon isotopes that may be the first indication of a decoupling of neutron and proton degrees of freedom in a nucleus. More recent results include a better understanding of the changes in structure for heavy F, Mg, and Si isotopes and the first measurement of the first excited states in ^{54}Ca. For nearly a decade the ^{54}Ca state was actively sought by researchers around the world due to its importance in distinguishing between nuclear models.

A significant and exciting number of results have been achieved in beta-decay studies. These include results that lead to two press conferences in 2011, one on the discovery that nuclei critical to nucleosynthesis in the r-process have much faster half-lives than predicted; the other, the discovery of a new magic number in heavy Zirconium isotopes, the first time such a change in shell structure has been observed in heavier nuclei. Although no results have been published the new EURICA collaboration based on the former EUROBALL gamma-ray detector promises to yield many breakthrough results.

The Laboratory has produced a number of significant results on the structure of exotic isotopes using various nucleon transfer and removal reactions as well was elastic and inelastic scattering. From proton knockout reactions on ^{8}He, there is evidence for the modification of the ^{6}He core. Other programs on nuclear reactions, transfer, knockout, charge exchange, etc. are underway, but have limited published result so far. A significant future program addressing the nuclear equation-of-state will be discussed below.

Laboratory Management

Professor Sakurai's management style is to encourage his permanent staff to concentrate on his/her own research program as a "project leader". Several of the permanent staff, who have been working on his/her own project for many years before Sakurai came to RIKEN as a chief scientist, are allowed to continue this research. Sakurai supports and encourages each of them by giving advice through weekly meetings and private discussions. The result is widespread satisfaction with his management and the feeling among laboratory staff that they are given the support needed for success in their research.

We found that Professor Sakurai's management policy is working well to produce the maximum scientific output from each of the projects. To keep and enhance the productivity, Sakurai will need to continue to carefully watch each of the projects and be prepared to take control to change direction or rearrange activities of any underperforming projects, if necessary.

In addition, Professor Sakurai's style of supporting various research activities is particularly effective to encourage participation from leading physicists from abroad. This effort benefits the development of this field worldwide. However, some of the permanent staff are required to spend significant time to take care of foreign visitors and to assist in experiment coordination, data analysis, and publication preparation. These added roles can result in an overloaded workload for the staff. Professor Sakurai should carefully monitor these situations.

One outcome of Professor Sakurai's management style is that the scientific direction of Sakurai's laboratory is more diverse than normal. However, we understand this is a temporary situation and note that when new chief scientists in the Nishina Center are appointed, as expected in the near future, some of the activities will shift to these laboratories. Hence, in the future, it will be more reasonable for Professor Sakurai to focus his research activities.

As a professor of University of Tokyo (UT), Sakurai has successfully recruited graduate students in UT into his field and brought them up at the world-best, exciting environment of RIBF. Recruitment of students is particularly important to ensure future development of this field. We are very encouraged that the RIKEN management has accepted a dual role for Professor Sakurai and feel this is the correct action to maximize the scientific impact of the laboratory. The allowance of

such a joint role will serve to keep good relations with the University of Tokyo and benefit both institutions.

Future Research Plans

We find that Professor Sakurai has developed a good mix of short-range plans centered around new equipment initiatives that he is leading, and longer-range strategic visions for the Nishina Center. We briefly describe each of these areas.

Short-range plans

The near-term research emphasis of the laboratory will be placed on development of SHOGUN and the SAMURAI-TPC. The former equipment is a multi-$LaBr_3$(Ce) array for in-beam gamma spectroscopy and beta-decay study. It is hoped that the cost will be covered by East-Asian collaboration including Korea and China. Besides the cost coverage, the collaboration is strategically important in view of the fact that it may form a research basis in Asia to compete with EU-FAIR and USA-FRIB facilities in the future. Scientific outcome is highly promising by extending the past achievements of the SAKURAI Laboratory.

The SAMURAI-TPC is devoted to the study of the EOS of asymmetric nuclear matter by a large-scale international collaboration. The project is challenging in view of the fact that solving this issue requires elaborate experimental efforts and theoretical interpretation of experimental results. However this activity may result in a significant amount of the highest-impact future scientific output of the Rare Isotope Laboratory.

Long-range plans

The intensity of the primary Uranium beam is planed to increase from the present value (1 pnA) in 2012, through about 100pnA in 2016 and to about 500 pnA in the farther future. The purpose is to drastically extend an accessible region in the production of neutron-rich nuclei close to and even beyond the r-process path. This is a strategic ingredient from the viewpoint of accelerator for post-RIBF facility to compete with EU-FAIR and USA-FRIB facilities in the future. It is recommended to strategically set up physics goals of the post-RIBF facility by organizing workshops at right times.

Overall Assessment

Our overall conclusion is that Professor Sakurai is performing at an exceptional level and that the Radioactive Isotope Physics Laboratory is world-leading in its area of research. The laboratory pursues and enables forefront research into the nature of

atomic nuclei and provides an important role in encouraging significant international participation in the Nishina Center Radioactive Ion Beam Factory.

Other Comments

none